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Ball screw and method for producing a spindle nut, in particular of a ball screw

The present invention relates to a method for producing a spindle nut, in particular of a ball screw, and to a ball screw.

DE 199 44 875 A1, for example, discloses a ball screw with a spindle and a nut surrounding the latter, and also with balls arranged in between, which are arranged in such a way that they can roll in a thread groove formed on the outer surface of the spindle and in a corresponding thread groove formed on the inner surface of the nut. Also provided on the nut are radial through-openings, in which deflecting pieces are fitted for the return of the balls respectively from a run-out end of a common turn of the thread grooves to a run-in end of this turn. The nut is configured as a one-piece sleeve with a circular-cylindrical casing and each fitted deflecting piece is arranged in the associated through-opening of the nut completely within the outer casing. The through-openings are usually produced by machining. In this process, burr may be produced at the rim of the through-opening, which is not only obtrusive but also impairs the satisfactory function of the ball screw. In particular where the rim of the through-opening goes over into the thread groove of the spindle nut, burr can lead to considerable

problems. When the deflecting piece is fitted in the through-opening and the rolling ball rolls out of the thread groove of the spindle nut into the deflecting channel of the deflecting piece, or is pressed in by following balls, it may cant at the burr and block the circulation of the balls.

The object of the present invention is to provide a method for producing a spindle nut with which this disadvantage is avoided.

According to the invention, this object is achieved by a hole punch which is arranged within the spindle nut punching out the through-opening from radially inward to radially outward through the casing of the spindle nut. The punching out from inward to outward offers decisive advantages. On the one hand, the effect of a punching draw-in that occurs in punching operations is utilized. This punching draw-in occurs on the workpiece on its surface facing the hole punch. On the finished workpiece, this punching draw-in is manifested as a slight rounding at the punched opening. In the case of the method according to the invention, the punching draw-in is used in a particularly favorable way, in that it is formed on the radially inner rim of the through-opening. This means that, in particular, the rim at the transition from the through-opening to the thread groove of the spindle nut takes the form of a slight convex rounding. This in turn has the consequence that it is ensured that no

undesired burr can form in the region of the circulation of the balls, in particular in the transition from the through-opening to the thread groove.

A further advantage of the method according to the invention is that the cut portion of the punching operation is formed radially on the inside of the wall of the through-opening. The cut portion, which is formed with high precision on the workpiece, permits exact dimensioning of the through-opening to be punched out. This means that the deflecting piece can be satisfactory positioned in the through-opening, to be precise can be fitted radially on the inside. The torn-out portion of the punching operation is formed radially on the outside of the outer side of the spindle nut during punching, and takes the form of a slightly conical widening. This effect that occurs can also be advantageously utilized for the purpose of allowing the deflecting piece to be fitted unproblematically into the through-opening from radially the outside on account of the conical widening.

The punching tool preferably comprises not only the hole punch but also a threaded spike, the thread profile of which is formed as a negative profile in relation to an inner thread of the spindle nut forming a thread groove for balls, the hole punch being arranged radially displaceably in the threaded spike, and the spindle nut being arranged on the

threaded spike, whereby the hole punch is moved radially outward out of the threaded spike. The fact that the spindle nut is arranged on the threaded spike before the punching-out operation allows exact positioning of the hole punch with respect to the spindle nut. This means that, even if a number of hole punches provided in the threaded spike are used, the through-openings are punched at exactly the intended locations after the positioning of the spindle nut on the threaded spike.

In the case of a ball screw according to the invention, the rim of the through-opening lying on the inner circumference of the spindle nut has a convex rounding. As already described in detail at the beginning, this convex rounding is the result of a punching operation from radially inward to radially outward, the punching draw-in causing this rounding according to the invention. However, other methods by which this convex rounding is achieved may also be provided. According to the invention, it is in any event ensured by this convex rounding that no undesired burr can be formed in the transitional region of the thread groove of the spindle nut and the through-opening.

The invention is explained in more detail below on the basis of an exemplary embodiment that is represented in altogether five figures, in which:

Figure 1 shows a perspective representation of a spindle nut according to the invention,

Figure 2 shows a cross section through the spindle nut according to the invention from Figure 1,

Figure 3 shows an enlargement of a detail of the spindle nut according to the invention from Figure 2,

Figure 4 shows a method for producing the spindle nut according to the invention from Figures 1 to 3 and

Figure 5 shows a ball screw according to the invention in a simplified representation.

The ball screw according to the invention that is depicted in Figure 5 comprises a spindle nut 2, arranged on a spindle 1, and balls 3, which are merely represented here by dashed lines. The balls 3 can roll on a thread path 4. The thread path 4 comprises a thread groove 5 formed on the spindle 1 and a thread groove 6 formed on the spindle nut 2. The spindle nut 2 is provided with a number of receptacles 7, arranged distributed over the circumference, for receiving deflecting pieces 8. Each deflecting piece 8 comprises a deflecting channel 9 for the return of the balls 3 respectively from a run-out end 10 to a run-in end 11 of at least one common turn 12 of the thread path 4.

Figure 1 shows a spindle nut 2 according to the invention as a single part, with through-openings 7 punched out from radially inward to radially outward.

The sectioned through-opening 7 can also be seen in Figure 2.

Figure 3 then shows in an enlarged represented the wall 13 of the through-opening 7. The rim 14 of the through-opening 7 lying on the inner circumference of the spindle nut 2 has a convex rounding 15 at the transition to the thread path 4, and in particular to the thread groove 5 of the spindle nut 2. The part 16 of the wall 13 adjoining the rim 14 is formed in a cylindrical manner or in the form of a slot with mutually parallel wall portions. The adjoining part 17 of the wall 13 is slightly conically widened.

Figure 4 shows a method for producing the spindle nut 2 according to the invention that is described above, to be precise in particular the production of the through-opening 7, as it is represented greatly enlarged in Figure 3.

According to Figure 4, a punching tool is provided, comprising a threaded spike 18 and one or more hole punches 19 arranged in the threaded spike 18. The threaded spike 18 has a thread profile 20, which is formed as a negative profile in relation to the thread groove 5 of the spindle nut 2. The hole punch 19 is arranged radially displaceably in the threaded spike 18. Furthermore, the punching tool comprises a female die 21, which is provided with an opening 22 for receiving punched-out material of the spindle nut 2 and the hole punch 19.

To produce the through-opening 7, the hole punch or punches 19 are displaced radially outward, material being punched out from the spindle nut 2. The punching draw-in that usually occurs on the workpiece in punching operations takes the form here, according to the invention, of the convex rounding 15 described further above on the inner rim 14 of the through-opening 7. Likewise as a consequence of the punching operation from radially inward to radially outward, the cut portion adjoins the radially inner rim, which has already been referred to further above as the part 16 of the wall 13. Adjoining this, the torn-out portion can be seen, likewise formed as a consequence of the punching operation and already referred to further above as the conical part 17 of the wall 13.

The convex rounding 15 has the advantage that no undesired burr is formed on the thread path 4 or the thread groove 5 of the spindle nut 2 at the transition to the through-opening 7. The part 16 of the wall 13 is in the present case the cut portion of the punching operation. This cut portion can be produced with high precision, so that the deflecting piece 8 can be fitted exactly into the through-opening 7. The conical widening of the through-opening 7 as a consequence of the conical part 17 of the wall 13 makes it possible for the deflecting piece 8 to be fitted unproblematically from radially the outside.

List of reference numerals

1	spindle
2	spindle nut
3	ball
4	thread path
5	thread groove
6	thread groove
7	through-opening
8	deflecting piece
9	deflecting channel
10	run-out end
11	run-in end
12	wall
13	wall
14	rim
15	convex rounding
16	part of the wall
17	part of the wall
18	threaded spike
19	hole punch
20	threaded profile
21	female die